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THE SPRING MIGRATION OF WESTERN SANDPIPERS AND DUNLINS IN SOUTHCENTRAL ALASKA: NUMBERS, TIMING, AND SEX RATIOS

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The Pacific coast from Puget Sound to western Alaska north of the Alaska Peninsula is dominated by fjord-like topography. In this region, as well as the Pacific coast of the Americas generally, there are few coastal wetlands available as stopping areas for those shorebird species which migrate between southern wintering areas and Alaskan breeding grounds and typically use coastal wetlands for feeding and resting purposes (Isleib 1979, Pitelka 1979). Because the availability of coastal wetlands is limited and is being further reduced through man-induced environmental change (e.g., Speth 1979), it is important to document the use and significance of such areas in the annual cycles of long-distance migrant shorebirds (Pitelka 1979, Duffy et al. 1981).

In this paper we describe the numbers, timing, and sex ratios of Dunlins (*Calidris alpina*) and Western Sandpipers (*C. mauri*) using intertidal habitats at 2 locations in southcentral Alaska: the combined deltas of the Copper and Bering rivers and lower Cook Inlet (Fig. 1).

RANGES

Two races of Dunlins are recognized as breeding in Alaska. The short-billed *C. a. sakhalina* (MacLean and Holmes 1971, Norton 1971; Browning 1977 calls it *C. a. arcticola*) breeds in northern Alaska and winters in Asia, while *C. a. pacifica,* a darker, long-billed race, breeds on the Yukon-Kuskokwim Delta and the Seward Peninsula and winters from the northern Gulf of Alaska to Baja California (MacLean and Holmes 1971, Isleib and Kessel 1973). Unless noted otherwise the Dunlin referred to throughout this paper is the *C. a. pacifica.*

No races or discrete breeding populations of Western Sandpipers are recognized. The prime breeding range for this species is the Yukon-Kuskokwim Delta and the Seward Peninsula, while they winter along the Pacific coast from California to Peru and along the southern Atlantic coast and Gulf of Mexico, south to Central America and northern South America (A.O.U. 1957, Blake 1977).

STUDY AREAS AND METHODS

Study areas.—The Copper-Bering rivers delta system (hereinafter C-BRD system), covering an area of 1000+ km^2, includes barrier islands, intertidal zone, and associated wetlands between and including Controller Bay and Orca Inlet (Fig. 1). Tides average 3.5 m, with a marked inequality between successive low waters (Rosenberg 1972). Local climatic conditions are typical of coastal, southcentral Alaska (Isleib and Kessel 1973). Snowfall is highly variable and of major importance in determining which habitats are available for use by spring migrant shorebirds. In late April and May of most years the snow and ice cover on supratidal wetlands afford only limited open water in melt pools on the periphery of ponds. On 3 May 1975 the Copper River Delta was about 50% snow-covered (Bromley 1976). In 1976 snow cover was probably more extensive on this date; in 1977–1979, less extensive. The general result is that migratory shorebirds are confined primarily to ice-free intertidal areas for feeding.

Within the C-BRD system our study focused on tidal flats and adjacent wetlands at 2 sites: Kanak Island in Controller Bay (60°05′N, 144°18′W) and Hartney Bay in Orca Inlet (60°30′N, 145°52′W) (Fig. 1). Both sites are described in detail in Senner (1977, see also Senner 1979).

Cook Inlet is a 300-km-long drowned river system that narrows toward its inland, northern, river-fed extremities (Fig. 1). The lower Cook Inlet region has less snowfall and a more rapid warming trend than does the C-BRD system, hence, potentially offering greater availability of supratidal habitats for migrant shorebirds (OCSEAP 1979). However, because of its fjord-like bays, even the large tidal amplitudes ($\geq$5 m) expose relatively little intertidal area suitable for feeding purposes. Kachemak Bay is the only eastern branch of the inlet with significant intertidal habitats. The bay benefits from clear oceanic waters which bathe the eastern side of lower Cook Inlet, and it has some of the highest productivity values for marine invertebrates within the region (Wennekens et al. 1975). In contrast, intertidal habitats on the western shore of lower Cook Inlet are subject to the flow of fresher, more silt-laden river waters and, therefore, provide less stable substrates for marine invertebrates than those of Kachemak Bay (OCSEAP 1979).

Within Kachemak Bay our study focused on the Fox River Flats and Mud Bay at the base of Homer Spit (59°45′N, 151°05′W). On the western shore of lower Cook Inlet 3 sites were surveyed: Iniskin Bay (59°45′N, 153°25′W), Chinitna Bay (59°50′N, 153°10′W), and the coast bracketing the mouth of the Drift River (60°40′N, 152°08′W) (Fig. 1).

Methods.—The locations and dates of our field work were as follows: Kanak Island—27 April–20 May 1976 and 30 April–16 May 1977; Hartney Bay—2–6 May 1975, 27 April–27 May 1976, 30 April–26 May 1977, 29 April–12 May 1978, and 1–14 May 1979; and lower Cook Inlet—30 April–21 May 1977. All field work in lower Cook Inlet was performed on contract by D. Erikson.

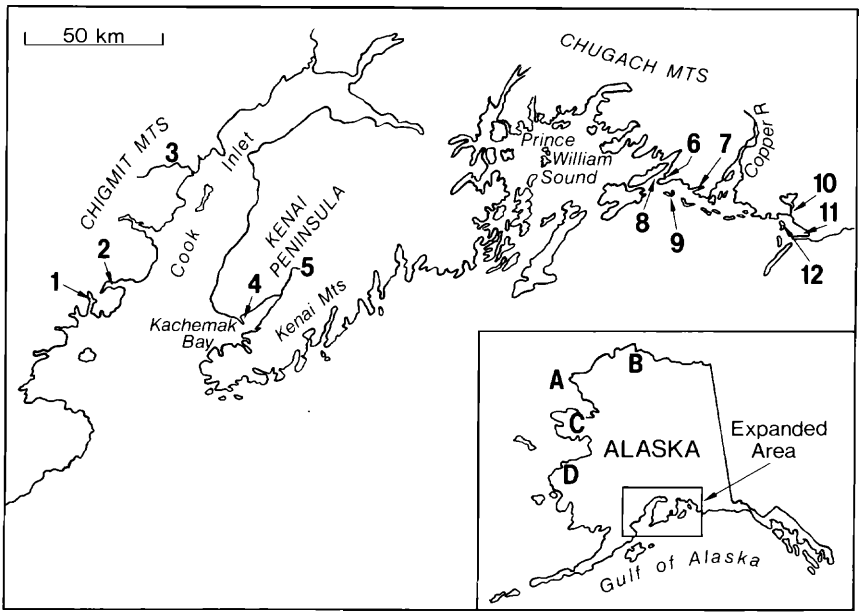

FIGURE 1. The northern Gulf of Alaska coast showing study areas in the Copper-Bering River Delta system and Cook Inlet. Locations identified by number are: (1) Iniskin Bay, (2) Chinitna Bay, (3) Drift River, (4) Mud Bay, (5) Fox River, (6) Hartney Bay, (7) Alaganik Slough, (8) Orca Inlet, (9) Egg Island, (10) Bering River, (11) Controller Bay, and (12) Kanak Island. The inset map illustrates: (A) Chukchi Sea, (B) North Slope, (C) Seward Peninsula, and (D) Yukon-Kuskokwim Delta.

In the C-BRD system in 1975–1978, we collected 174 Dunlins and 186 Western Sandpipers from which we obtained body measurements (exposed culmen and flattened wing lengths) and sex ratios. At Kachemak Bay we collected 8 Dunlins and 29 Western Sandpipers. To provide a basis for comparisons with specimens from southcentral Alaska, P. Connors collected 11 Dunlins and 21 Western Sandpipers at Bodega Bay, California (38°20′N, 123°03′W) between 26 April and 3 May 1976. At 3 sites on the Chukchi Sea coast (65°35′N, 168°05′W/66°35′N, 163°30′W/67°06′N, 163°42′W) we collected 19 Dunlins and 25 Western Sandpipers from 2–3 June 1976 and 28–30 May 1977 (Fig. 1).

In order to test whether samples of both species collected at the various locations were members of single populations, we compared body measurements among sites and between years for specimens collected in 1976 and 1977, the years in which the data were gathered at the primary study sites. All statistical comparisons in this paper were performed at a significance level of $P < .05$. For Dunlins there were no significant differences between years, so data for all years were combined for a single location. Among Western Sandpipers there were dif-

ferences between years, and, thus, the years are treated separately. We used Duncan's Multiple Range (DMR) test (Nie et al. 1975) to assess the hypothesis that samples from different locations were members of the same populations. Mean values for a single dependent variable were tested, comparing all possible pairs of group means. The groups were divided into homogeneous subsets, where the difference in the means of any 2 groups is not significant at a predetermined level of probability.

Information on the numbers and species composition of migrants at Hartney Bay was derived by 2 methods. First, we determined species composition by 113 and 122 direct counts in 1976 and 1977, respectively, of shorebirds on an hourly basis through at least half of a 12 h tide cycle (i.e., high to low or low to high tides) on 2 transects (I = 600 × 50 m, II = 300 × 50 m; see Senner 1977). Second, we also estimated peak numbers of each species (maximum number present at any one time, usually near high tide, on a given day) in 1976–1979 at Hartney Bay. These data were summarized by averaging the numbers recorded in the different years for each date. We have peak estimates in more than one year for 17 dates; on 6 dates we have only a single estimate. A least squares regression was calculated for the estimated proportion of Western Sandpipers (percentage of total of Western Sandpipers and Dunlins) versus date.

In 1977 at Kanak Island we used mist nets or wire walk-in traps to capture 279 Western Sandpipers and 2 Dunlins. Each bird was banded with a U.S. Fish and Wildlife Service aluminum leg band and color-marked with a brightly-colored feather glued to a central rectrix (West et al. 1968). In 1978 and 1979, 1105 Western Sandpipers and 44 Dunlins were mist-netted, banded, and color-marked at Hartney Bay. Weight, culmen length, and flattened wing length were recorded for each bird. Sightings of color-marked birds provided the basis for estimates of lengths of stay at the study sites. Three round trips flown in a Cessna 180 low (roughly 30 m) over the water's edge between Cordova and Kanak Island in 1977 afforded an opportunity to search for color-marked birds and to note species composition, numbers, and areas of concentration.

We determined sex ratios by date for Western Sandpipers and Dunlins in the C-BRD system from all specimens collected and sexed by examination of the gonads or captured and sexed by culmen length (Page and Fearis 1971, Page 1974). A least squares regression was calculated for the percentage of males versus date (all years combined).

At Kachemak Bay Erikson flew 6 aerial surveys in a Cessna 172, one hour before high tide, covering the area between and including Mud Bay and the Fox River flats (Fig. 1). On the western shore of lower Cook Inlet, the mouth of the Drift River, Chinitna Bay, and Iniskin Bay (Fig. 1) were each surveyed once. Survey techniques replicated those used in an earlier study by the Alaska Department of Fish and Game (Erikson 1977). Erikson made 3 on-the-ground trips to the Fox River flats, in part for the purpose of verifying the species composition of shorebirds

seen from the air. To complement the aerial surveys, a 500 × 300 m study plot located at Mud Bay (Fig. 1) was censused after high tide on 12 days. Each census consisted of a complete count of all shorebirds on the plot as it was exposed by the receding tide.

RESULTS

Mensural characteristics.—Based on the DMR test, culmen lengths of Dunlins, within sexes, were not statistically different among sample locations, except those of birds collected on the Chukchi Sea coast, which were significantly shorter. Mean wing lengths did not differ significantly among locations (Table 1).

In 1976 there were no differences within either sex of Western Sandpipers in culmen or wing lengths among locations (Table 1). However, in 1977 the culmen lengths of male Western Sandpipers in the Chukchi Sea coast sample were shorter than in any other sample. Wing lengths of males in the Chukchi Sea coast sample differed significantly only from the Kanak Island sample. Culmen lengths of males collected at Kachemak Bay were shorter than those collected at Hartney Bay, but similar to those collected at Kanak Island. The wing lengths of female Western Sandpipers at Kachemak Bay were shorter than those of birds in the C-BRD system; culmen lengths, however, did not differ among sample locations (Table 1).

Species composition and numbers.—Our overflights of the C-BRD system showed that the perimeter of Controller Bay, the East Copper River Delta, and the west side of the Copper River Delta from Alaganik Slough into Orca Inlet (Fig. 1) were areas which consistently attracted large numbers of shorebirds. Ground observations at several sites within the C-BRD system established that shorebirds generally moved from east to west across the system, such that to a northbound migrant Controller Bay represents the first, and Orca Inlet, the last, stopping opportunity.

In 1976 and 1977, 12,844 and 6961 shorebirds, respectively, were recorded on censuses of the Hartney Bay intertidal transects. Dunlins and Western Sandpipers, combined, accounted for 94% of all shorebirds in 1976 and 96% in 1977 (Fig. 2). Observations elsewhere in the C-BRD system bore out the predominance of these species in intertidal and adjacent habitats during spring migration.

Few migrant shorebirds were present at Hartney Bay before 30 April, and the bulk of the migration had passed by mid-May. On average the greatest number of shorebirds at Hartney Bay was recorded on 7 May (Fig. 3), although within individual years the peaks varied between 2 and 10 May. The only year in which bimodal peaks were recorded was 1978 (2 and 7 May). Annual variations in the numbers of shorebirds using Hartney Bay on a given date were great; for example, high and low numbers in 3 years of records on 7 May varied by a factor of 15.6.

At Hartney Bay the proportion of Western Sandpipers versus Dunlins varied from day to day, although generally the proportion of Western Sandpipers relative to Dunlins declined through May. Regression equa-

TABLE 1. Mean culmen and wing lengths ($\bar{x}$ ± 1 SD (n)) of Dunlin and Western Sandpiper specimens at 5 study sites on the western North American coast.

		Bodega Bay	Controller Bay	Hartney Bay	Kachemak Bay	Chukchi Sea
Dunlin: 1976 and 1977 (combined)						
Culmen	M[1]	37.1 ± 1.3 (7)	37.1 ± 1.6 (27)	37.2 ± 1.3 (49)	38.1 ± 1.3 (4)	33.9 ± 2.0 (11)
	F	40.4 ± 1.1 (4)	40.7 ± 1.7 (35)	40.9 ± 1.5 (55)	41.7 ± 1.3 (4)	37.7 ± 1.7 (8)
Wing	M	123.9 ± 2.2	124.2 ± 2.5	125.3 ± 2.7	126.0 ± 1.4	123.4 ± 2.3
	F	127.0 ± 2.0	127.5 ± 2.7	128.1 ± 2.5	128.5 ± 1.3	127.3 ± 2.8
Western Sandpiper: 1976						
Culmen	M	23.2 ± 0.9 (12)	23.3 ± 1.0 (41)	22.8 ± 1.3 (27)	—	23.2 ± 0.6 (6)
	F	27.0 ± 1.1 (9)	27.2 ± 1.1 (27)	27.3 ± 1.2 (18)	—	27.2 ± 1.3 (3)
Wing	M	98.1 ± 1.4	98.6 ± 2.3	99.9 ± 2.1	—	98.0 ± 2.6
	F	101.1 ± 1.5	102.5 ± 2.3	102.8 ± 2.5	—	102.3 ± 2.5
Western Sandpiper: 1977						
Culmen	M	—	23.3 ± 0.7 (10)	23.6 ± 1.0 (15)	22.8 ± 1.0 (11)	22.0 ± 0.5 (12)
	F	—	27.3 ± 1.1 (15)	26.9 ± 1.2 (20)	27.3 ± 1.0 (18)	26.4 ± 1.3 (4)
Wing	M	—	99.0 ± 1.3	98.5 ± 1.7	98.1 ± 1.9	97.0 ± 2.9
	F	—	103.1 ± 1.8	103.4 ± 1.7	101.1 ± 2.2	101.8 ± 1.3

[1] M = male, F = female.

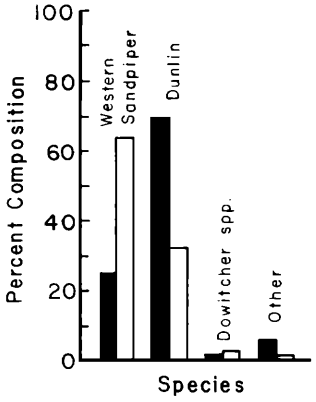

FIGURE 2. Relative abundance of different shorebird species at Hartney Bay in 1976 (solid bars) and 1977 (open bars).

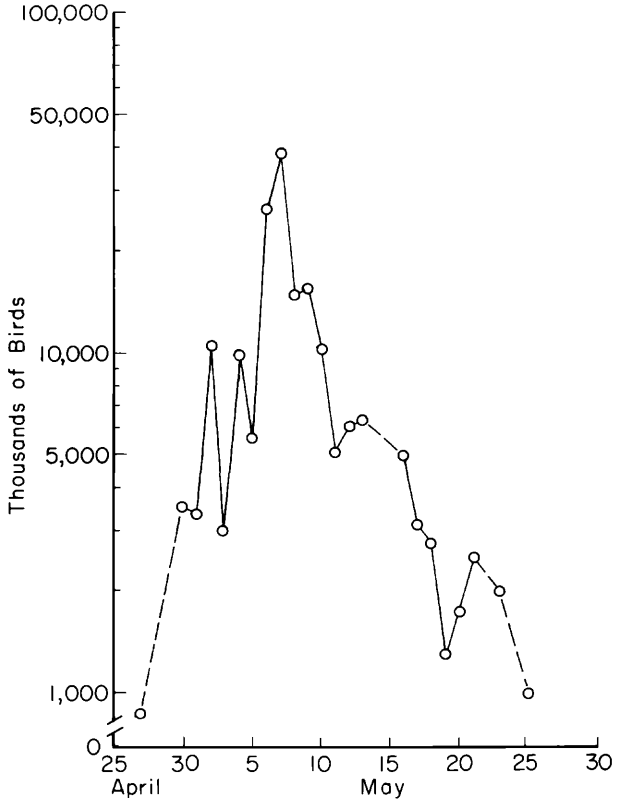

FIGURE 3. Average estimated peak numbers of shorebirds at Hartney Bay, 1976–1979.

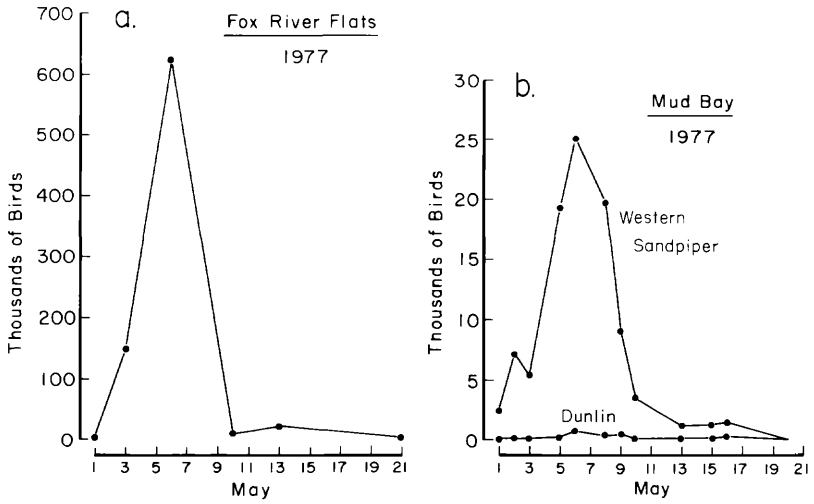

FIGURE 4. (a) Numbers of shorebirds on the Fox River flats in Kachemak Bay as estimated by aerial surveys. (b) Numbers of shorebirds a. Mud Bay in Kachemak Bay as determined by counts within a 500 × 300 m study plot.

tions for the percentage of Western Sandpipers by date in May were: 1978—% Western Sandpiper = 65.82 − 3.21(date in May), $r = .58$; 1979—% Western Sandpiper = 86.46 − 3.66(date in May), $r = .87$.

At Kachemak Bay more than 600,000 small shorebirds, which ground observations showed to be mostly Western Sandpipers, were recorded on the 6 May 1977 aerial survey of the Fox River flats (Fig. 4a). Peak numbers were recorded on the Mud Bay transect on the same date, with Western Sandpipers outnumbering Dunlins approximately 42 to 1 (Fig. 4b). Small to moderate numbers of shorebirds were recorded on aerial surveys of sites on the western shore of lower Cook Inlet: Drift River—12,000 small shorebirds (10 May); Chinitna Bay—4400 small shorebirds (12 May); and Iniskin Bay—1000 small shorebirds (12 May).

Lengths of stay.—Color-marked Western Sandpipers on Kanak Island were sighted at intervals ranging from 1 to 4 days after release (Table 2); 7 of 9 birds were sighted 1 to 2 days after release. At Hartney Bay color-marked individuals tended to remain longer, with sightings ranging from 1 to 9 and 1 to 8 days after release, respectively, in 1978 and 1979. At Hartney Bay, 43 of 49 total sightings were from 2 through 6 days after release (Table 2). In 1978 one color-marked Western Sandpiper was sighted on Egg Island near the mouth of Orca Inlet (Fig. 1) by M. E. Isleib (pers. comm.), 1 to 2 days after its release at Hartney Bay. No color-marked sandpipers of either species were sighted or recovered elsewhere.

Sex ratios.—The proportion of male Western Sandpipers decreased significantly through the migration period (% male = 73.95 − 2.09(date

TABLE 2. Numbers of color-marked Western Sandpipers sighted after initial capture and banding at 2 sites in the C-BRD system.

Location & year	Number of sandpipers marked	Number of days between capture and subsequent sightings[1]									Number of marked sandpipers sighted
		1	2	3	4	5	6	7	8	9	
Kanak I.—1977	279	4	3	1	1						9
Hartney Bay—1978	157		2		1	1	1			1	6
Hartney Bay—1979	848	3	8	7	10	5	8	1	1		43

[1] In some cases the interval between marking and sighting is known only as a range (e.g., 1–3 days), in which cases the average was used for purposes of this table.

after 30 April), $r = .77$, n = 1542 individuals on 15 days). In Dunlins the proportion of males was unrelated to date (n = 243 individuals on 18 days).

DISCUSSION

Both Western Sandpipers and Dunlins are primarily Pacific coast migrants (see description and references in Senner 1979). North of the Fraser River Delta, British Columbia, at which flocks of up to 100,000 Western Sandpipers have been recorded (Kaiser 1980), we know few details of the migration of either species. Munro and Cowan (1947) classified Dunlins and Western Sandpipers, respectively, as abundant and common migrants on the British Columbia coast, while at Glacier Bay, Alaska, Wik and Streveler (1967) considered both species to be common.

No area north of the Fraser River Delta has been identified as attracting the large numbers of shorebirds that are concentrated in the C-BRD system in spring. Isleib and Kessel (1973) and Isleib (1979) estimate that in late April and May more than 20 million waterfowl and shorebirds, at least half of which are Dunlins and Western Sandpipers, pass through the Copper River Delta. Our censuses at Hartney Bay bear out the predominance of both species (Fig. 2). Although Holmes (1966) suggested that Dunlins move north to British Columbia and then fly directly across the Gulf of Alaska to western Alaska, in view of the large numbers of Dunlins stopping in the C-BRD system, we believe that for most spring migrants it is more likely that the C-BRD system serves as the first landfall in Alaska. However, lacking surveys at sites such as the Queen Charlotte Islands, British Columbia and the Stikine River Delta, Alaska there is no direct basis for evaluating the extent to which Dunlins or Western Sandpipers make non-stop, over-water flights versus a series of shorter "hops" along the coast.

In either case, comparisons of body measurements (Table 1) confirm

that Western Sandpipers and Dunlins collected in the C-BRD system are members of the same populations that stop at Bodega Bay, California. The recovery of a Dunlin at Hartney Bay that had been banded 10 days earlier by G. W. Kaiser on the Fraser River Delta, British Columbia is further evidence that Pacific coast Dunlins stop in the C-BRD system.

Migrants may "enter" the C-BRD system at any point, although we expect Controller Bay to have a higher proportion of new arrivals than Hartney Bay at the western extreme of the system (Fig. 1). Movement within the system is from east to west, with the gross distribution of shorebirds presumably reflecting the suitability of different locations as feeding and resting sites (cf. Wolff 1969, Goss-Custard et al. 1977). Sightings of color-marked Western Sandpipers at Kanak Island (Table 2) suggest a rapid turnover at the eastern end of the system. Based on changes in species composition, Isleib (1979) estimated that there was a complete turnover in the population of spring migrants at Orca Inlet every 3 tidal cycles (36 h) in 1973, while sightings of our color-marked Western Sandpipers at Hartney Bay suggest more extended stops (Table 2). We view our results as defining maximum lengths of stay, while Isleib's (1979) more subjective estimate probably represents the minimum.

With respect to timing, the passage of Western Sandpipers at Hartney Bay agrees well with reports from more southern locations (Senner 1979). In 6 years of surveys at Bolinas Lagoon, California, the peak of the Western Sandpiper migration was in the last days of April and very early May (Page et al. 1979), while at Hartney Bay, few sandpipers arrive before 30 April. Males precede females in the C-BRD system generally, as one would expect from the evidence of geographic separation of the sexes on wintering grounds (Page et al. 1972, Gerstenberg 1972) and Holmes' (1973) report that males arrive first on Yukon-Kuskokwim Delta breeding grounds.

We would also expect Dunlin males to predominate early in migration (Holmes 1971, Page 1974), but our data do not bear out this prediction. Dunlin migration at many locations in California, at least, is characterized by a lack of a conspicuous spring peak, but the general timing of Dunlin passage is consistent with our results at Hartney Bay (Senner 1979). Although Western Sandpipers tended to predominate over Dunlins early in migration at Hartney Bay, there was no clear evidence that the periods of peak abundance for these species were staggered, as may be the case in other instances (Page et al. 1979).

Based on a comparison of estimated flight ranges, Senner (1979) hypothesized that in migrating from the C-BRD system to western Alaska, Western Sandpipers, but not necessarily Dunlins, make intermediary stops in lower Cook Inlet. Our results, as well as observations in other years by D. Erikson (pers. comm.), confirm that large numbers of Western Sandpipers and relatively few Dunlins stop in Kachemak Bay in a migration period that is more compressed than that in the C-BRD system (Figs. 3 and 4b). Sites on the western shore of lower Cook Inlet

attract smaller (but not insignificant) numbers of shorebirds than Kachemak Bay (cf. Arneson 1978), a fact which is not surprising given the reduced suitability of western shore substrates for intertidal invertebrates (OCSEAP 1979).

The results of our morphometric comparisons (Table 1) do not permit us to assume that the Western Sandpipers using Kachemak Bay are members of the same population that passes through the C-BRD system. We suspect that among the Western Sandpipers at Kachemak Bay are a mix of individuals having reached the bay with or without a stop in the C-BRD system. The proportion of each may vary from year to year depending on conditions encountered in migration through southcentral Alaska as well as more southern points along the coast.

Our comparisons of body measurements suggest a degree of morphological variation heretofore unreported in Western Sandpipers. Further study is needed to determine whether the individuals collected at Kachemak Bay and on the Chukchi Sea coast represent populations that have breeding or wintering areas distinct from those used by C-BRD system migrants (cf. Senner and Martinez in press). This is very likely the case with the Dunlins we collected on the Chukchi Sea coast, in that the mean culmen lengths in our sample, within sexes, are indistinguishable from those of Barrow breeding populations reported by MacLean and Holmes (1971) and Browning (1978). These individuals, which we believed were migrants when collected, probably represent Dunlins of the subspecies which winters in Asia and breeds in Arctic Alaska. We do not know where migrants of this subspecies first reach Alaska, but it almost certainly is not in the C-BRD system or Kachemak Bay.

To migrating shorebirds the wetlands of the C-BRD system and Kachemak Bay stand out as "habitat islands" on the North Pacific coast. Although we lack population estimates for breeding Western Sandpipers and the *pacifica* subspecies of Dunlin, there can be little doubt that the C-BRD system is used by significant fractions of their entire populations. Kachemak Bay appears to be of little importance to Dunlins, but it is used by large numbers of Western Sandpipers. While the numbers of shorebirds using both areas, but especially the C-BRD system, imply a considerable importance from the standpoint of species conservation, a more detailed exploration of the ways in which Western Sandpipers and Dunlins exploit these habitats is essential to an evaluation of the significance of the C-BRD system and Kachemak Bay in their annual cycles. Such an exploration may also yield insights into the role of limited wetland environments in the evolution of long-distance migrant shorebirds.

SUMMARY

Little is known about the migration of Dunlins and Western Sandpipers between the Fraser River Delta, British Columbia and the Copper and Bering rivers delta system (C-BRD). Censuses of transects and general population estimates at Hartney Bay, within the C-BRD system,

show that these 2 species constitute about 95% of all shorebird species using intertidal habitats. The bulk of migration at Hartney Bay occurs between 30 April and 15 May, with peak numbers occurring between 2 and 10 May. Throughout the C-BRD system, male Western Sandpipers predominate early in migration, while this phenomenon was not observed with Dunlins. Sightings of color-marked Western Sandpipers at Kanak Island suggest lengths of stay of 1 to 2 days, while marked individuals sighted at Hartney Bay remained for intervals of 2–6 days.

Large numbers of Western Sandpipers, far outnumbering Dunlins, were recorded at Kachemak Bay in lower Cook Inlet. These data are consistent with the hypothesis that Western Sandpipers, unlike Dunlins, need to stop at intermediary sites such as Kachemak Bay while en route between the C-BRD system and western Alaska breeding grounds (Senner 1979). However, we were unable to confirm this hypothesis because Western Sandpipers collected in Kachemak Bay had body measurements distinct from specimens collected in the C-BRD system. Whether the Western Sandpipers collected at Kachemak Bay and on the Chukchi Sea coast have breeding or wintering areas different from those of individuals which use the C-BRD system needs further investigation. Migrant Dunlins collected on the Chukchi Sea coast probably represent the subspecies which winters in Asia and breeds in Arctic Alaska.

The C-BRD system and Kachemak Bay stand out as "habitat islands" on the North Pacific coast and attract large numbers of migrating shorebirds. Studies considering the ways in which Western Sandpipers and Dunlins exploit these limited wetland habitats are needed to fully evaluate the significance of the C-BRD system and Kachemak Bay in their annual cycles.

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